Novel $\text{CuIn}_{1-x}\text{Ga}_x\text{Te}_2$ Structures for High Efficiency Photo-electrochemical Solar Cells

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Novel $\text{CuIn}_{1-x}\text{Ga}_x\text{Te}_2$ (CIGT; $x = 0, 0.3, 0.5$ and 0.7) chalcopyrite structures for photo-electrochemical solar cells have been successfully synthesized via a facile co-precipitation method. Briefly, tetragonal chalcopyrite structure was perceived with as-synthesized CIT sample whereas chalcopyrite phase was accompanied with minor impurity phases of cubic In_2O_3 and hexagonal Te metal with increasing the Ga^{3+} ion ratio. Meanwhile, a slight increase in the unit cell volume of chalcopyrite crystals was observed with the substitution In^{3+} ions with different ratios of Ga^{3+} ions. Moreover, the microstructure characteristics of the as-prepared chalcopyrite samples were exhibited different morphologies with different Ga^{3+} ion concentrations. Furthermore, the band gap energy and calculated refractive index were leaned on the Ga^{3+} ion content. Generally, the J-V characteristic measurements were coherently performed for the corresponding photo-electrochemical solar cells using the as-prepared photo-electrode materials. Accordingly, $\text{CuIn}_{0.3}\text{Ga}_{0.7}\text{Te}_2$ sample was displayed the highest photovoltaic performance with conversion efficiency (η) $\sim 6.19\%$ and fill factor (FF) $\sim 24.98\%$, respectively. The superior power conversion performance was discussed based on the electrochemical impedance spectra (EIS) results which confirmed the enhanced electronic conductivities of the as-prepared photoelectrodes and exhibited well agreement with the obtained optical properties as well as J-V measurements.

Keywords: Chalcopyrite CIGT; Co-precipitation synthesis; Photovoltaic performance; Charge transfer resistance

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